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W. M. ElSayed^{1,2*}, S. A. Abu ElEla^{1,3}, N. M. Eesa¹. COMPARATIVE MORPHOMETRICS OF EGGS AND EGG-PODS OF SOME EGYPTIAN GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE, PYRGOMORPHIDAE). – Far Eastern Entomologist. 2017. N 329: 17-24.

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Summary. The data on the structure and morphometrics of egg-pods and eggs of two species of Pyrgomorphidae and eight species of Acrididae from El Manshiya district (Giza governorate, Egypt) are given.

Key words: Orthoptera, Acridoidea, Pyrgomorphae, egg-pod, egg, chorionic sculpture, froth, apical lid, egg mass index, Egypt.

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Резюме. Приведены данные по строению и морфометрии кубышек и яиц двух видов семейства Pyrgomorphidae и 8 видов семейства Acrididae, собранных в округе Эль-Маншия (Гиза, Египет).

INTRODUCTION

Information pertaining biodiversity and ecology of the grasshopper egg-pods in Egypt is very poorly known together with the factors affecting the distribution of the egg-pods, abundance and host plant selection by the adults is fragmentary. New data on the structure and morphometrics of eggs and egg-pods of two species of Pyrgomorphidae and eight species of Acrididae from Egypt are given below.

The area chosen for studying and collecting egg-pods (ca. 9 acres \approx 3642 m²) is located in El Manshiya district, Giza governorate, Egypt. This area is a part of the general plain of Giza province, lying approximately between latitude of 30°46'4" N and longitude of 31°10'47" E. As general topography is concerned, it is a flat area devoid of any elevations. Rurban abodes were located at all borders.

Regular weekly field excursions were performed for sampling and collecting different egg-pods (from May till August). These pods were obtained from the most favored ovipositional sites of adult female Acridomorpha species where pods would be expected pits appeared in the ground surface that could contain pods (Waloff, 1950; Khalifa, 1956; Chapman & Robertson, 1958; Chapman, 1961; Shah *et al.*, 1998; Shahpa, 2004; ElShazly & ElSayed, 2006; Abu ElEla *et al.*, 2010, 2012). Thus, searches took place along the edges of cultivated fields,

along the lines of the irrigating trenches, on yards of wild vegetation, lower branches of shrubs and bushes were excavated using bare hands and machetes where soil litters were removed. These searches were extended to a radius of 3 meter from the main trunk. Care was taken in collecting and handling to avoid breakage of the egg-pods.

The soil was scraped carefully with short-handle hoe in order to expose any egg-pod which may have been present at a depth of 20-120 mm as suggested by Zafari & Qazi (1989), Shah *et al.* (1998), ElShazly & ElSayed (2006), and Riffat & Wagan (2009). Pods were lifted using small stainless steel scoop and these pods were deposited singly in labeled empty glass jam jars (250 ml, diameter 6 cm and 11 cm deep) covered with cotton muslin. Collected materials were brought to the laboratory and caged in small ventilated wooden rearing cages (30 x 30 x 30 cm). These cages were placed under laboratory conditions where the temperature regimes fluctuated between $26-38 \pm 2^{\circ}\text{C}$, relative humidity of $60-68 \pm 2\%$ and photoperiod of 12L: 12D. The temperatures, relative humidity and photoperiod regimes were similar to the field conditions. Care was taken to supply the pods with moisture and they were examined daily for the emergence of nymphs. Identification of the emerged grasshopper species was carried up to species level by adopting the keys offered by Khalifa (1956) and Shahpa (2004).

In general, a total of 506 egg-pods belonging to 10 different species were collected. In order to record the quantitative analysis encompassing size and shape of the eggs and the egg-pods; morphometric analyses were adopted in the current study using ocular micrometer equipped in stereo-microscope. The arrangement of the egg mass within an egg-pod, the mean number of eggs/pod, the color of the froth and eggs, the chorionic patterns and the sculpture of the outer surface of the egg, which is often a characteristic of the species, were applied to identify different acridomorphine eggs. The color of the chorion was based on the spectrum offered by Munsell color system (Kuehni, 2002).

RESULTS AND DISCUSSION

The egg-pods and eggs of the collected grasshopper species showed a great diversity in their structure and morphometrics. Our present investigation yielded 506 egg-pods belonging to 10 different species (Table 1). In general, there was a large variation in the number of egg-pods. *Aiolopus thalassinus* appeared to harbor the highest number of egg-pods (92 pods) representing 18.4% of the total number of collected pods (Table 1). This was followed by *Acrotylus patruelis* with 72 collected pods representing 14.2% of the total number of collected pods. The least number of egg-pods was confined to *Sphingoderus carinatus* with only 17 egg-pods representing 3.36% of the total number of pods. *Aiolopus thalassinus* is assumed to have greater ecological plasticity (Waloff, 1950; Khalifa, 1956; Zafari & Qazi, 1989; Shahpa, 2004; ElShazly & ElSayed, 2006). Indeed, these variations in morphometrics of eggs and egg-pods for each species could be summarized as follow.

Acrida bicolor (Thunberg, 1815)

The egg-pods of this species (Acrididae: Acridinae) showed that the pods were cylindrical and always straight. The pod exhibited a mean length of 3.56 cm. The frothy part was white or buff in color and encompassed an average of 2.44 cm length (Fig. 1) with the absence of apical lid (Table 1). The egg mass was arranged in 2 vertical series with an egg mass index of 2.25. The eggs were cylindrical and slightly curved at the distal part. The color of the eggs was unmellow yellow and the mean length of an egg was 5.1 mm while the mean width was 0.46 mm (Table 2). The mean number of eggs was 22.3 eggs and the chorionic sculpture formed of dots in rows on the surface of the eggs.

Table 1. Number and morphometrics of egg-pods of the co-occurring grasshopper species inhabiting the study site at Manshyia district, Giza, Egypt.

Species	No. of collected pods	Apical lid*	Froth color	No. of eggs (mean \pm SD)	Egg mass index	Arrangement of eggs
<i>Acrida bicolor</i>	[54]	-	white or buff	22.3 \pm 3.258	2.25	2 vertical series
<i>Acrotylus patruelis</i>	[72]	-	white	25.2 \pm 1.924	2.389	3-4 inclined series
<i>Aiolopus thalassinus</i>	[93]	+	white or buff	38.2 \pm 3.271	2.263	4 radial series
<i>Calephorus comprissicornis</i>	[68]	+ -	white and fragile	12.7 \pm 2.787	2.5	3 oblique series
<i>Chrotogonus homalodemus</i>	[45]	-	shiny and light buff	28.33 \pm 6.186	2.333	4-5 vertical series
<i>Heteracris littoralis</i>	[52]	-	dark brown and coarse	34.5 \pm 4.087	1.957	2 vertical series
<i>Ochrilidia gracilis</i>	[58]	+ -	white to silver	15.2 \pm 2.588	1.231	3-4 inclined series
<i>Pyrgomorpha conica</i>	[21]	+ -	white	35.4 \pm 3.647	1.273	4-6 inclined series
<i>Sphingoderus carinatus</i>	[17]	-	silver to brown	9 \pm 4.183	1.615	2 inclined series
<i>Truxalis nasuta</i>	[26]	-	white or buff	17.2 \pm 2.49	2.355	2 vertical series

*Apical lid: (-) – absent, (+) – present, (+ -) – occasionally present.

***Acrotylus patruelis* (Herrich-Schäffer, 1838)**

The egg-pods of this species (Acrididae: Oedipodinae) showed that the pods were cylindrical and straight with the mean pod length of 4.2 cm while the frothy mass exhibited a length of 2.1 cm (Fig. 1) and the apical lid was completely missing in all examined pods (Table 1). It has to be mentioned that the apical part of the pod was being protected by the adhered soil particles where much of these particles could be noticed on searching of such pods. Eggs were arranged in 3-4 inclined series. The color of the froth was white and this species exhibited the highest value of egg mass index (2.389) among other co-occurring species (Table 1). On the other hand, the color of the eggs was light yellow with scattered fine dots on the surface of the chorion.

***Aiolopus thalassinus* (Fabricius, 1781)**

The examined egg-pods of this species (Acrididae: Oedipodinae) were generally cylindrical, straight and sometimes slightly bent at the bottom where the pod being broader at the basal part and narrowed towards the distal part (Table 1). The mean length of pods was 4.28 cm. A detachable thin apical lid could be always observed; this apical lid was almost covered with soil particles. The frothy part comprised a mean length of 1.7 cm (Fig. 1). The froth color was white or light buff (occurred in relatively moist and old pods). The egg mass index ranked this species in the third rank with a value of 2.263 and the eggs were arranged in four radial series. Concerning the eggs; they were canary yellow in color with the sculpture was formed of scattered dots on the surface.

Table 2. Color, morphometrics and chorionic sculpture of eggs of the co-occurring grass-hopper species inhabiting the study site at Manshiya district, Giza, Egypt.

Species	Color	Morphometric (mm) (mean \pm SD)		Chorionic sculpture
		Length	Width	
<i>Acrida bicolor</i>	unmellow yellow	5.1 \pm 0.058	0.46 \pm 0.114	dots in rows
<i>Acrotylus patruelis</i>	light yellow	3.83 \pm 0.153	1.1 \pm 0.1	scattered fine dots
<i>Aiolopus thalassinus</i>	canary yellow	4.5 \pm 0.158	0.9 \pm 0.1	scattered fine dots
<i>Calephorus comprissicornis</i>	canary yellow	3.64 \pm 0.207	0.5 \pm 0.122	scattered fine dots
<i>Chrotogonus homalodemus</i>	beige brown	4.04 \pm 0.3	1.3 \pm 0.158	analogous to parenchyma tissue
<i>Heteracris littoralis</i>	unmellow yellow	4.68 \pm 0.259	0.9 \pm 0.141	hexagons with corner and center spots
<i>Ochrilidia gracilis</i>	goldenrod yellow	4.34 \pm 0.207	0.88 \pm 0.13	dots in rows
<i>Pyrgomorpha conica</i>	jonquil yellow	4.68 \pm 0.148	0.86 \pm 0.182	fine hexagons
<i>Sphingoderus carinatus</i>	canary yellow	4.72 \pm 0.13	1.28 \pm 0.164	no sculpture
<i>Truxalis nasuta</i>	beige brown	5.58 \pm 0.192	1.02 \pm 0.217	dots in rows

***Calephorus compressicornis* (Latreille, 1804)**

The egg-pods of this species (Acrididae: Acridinae) showed that pods were cylindrical and frequently straight. The apical lid was weakly formed and sometimes absent in some collected pods (Table 1). The mean recorded length of pods of this species was 3.46 cm. The frothy part was very delicate and fragile, compared to other examined co-occurring species, and measured a mean length of 1.22 cm (Fig. 1). The eggs were arranged in three oblique series and the recorded egg mass index exhibited a value of 2.5 (Table 1). An egg was about 3.64 mm in length and 0.5 mm wide whereas the color of the chorion was canary yellow with scattered dots in the chorionic sculpture.

***Chrotogonus homalodemus* (Blanchard, 1836)**

A total of 45 egg-pods of this species (Pyrgomorphidae: Pyrgomorphinae) were examined and a typical pod was cylindrical and straight with the basal part slightly bent. The mean length of the examined pods was 6.32 cm which proved to exhibit the second position, concerning the mean length of pods, among other species examined (Fig. 1). The frothy part was shiny and light buff in color and comprised a mean length of 2.18 cm and the apical lid was always absent. The egg mass was arranged in 4-5 vertical series with egg mass index of 2.333. Observations on the eggs showed that they were cylindrical tapering at the anterior pole where the color of a typical egg was beige brown. The eggs exhibited characteristic chorionic sculpture analogous to parenchyma tissue.

***Heteracris littoralis* (Rambur, 1838)**

The majority of egg-pods of this species (Acrididae: Eyprepocnemidinae) were cylindrical and straight with basal part slightly bent with a mean length of 4.56 cm (Fig. 1). The egg mass was arranged in two vertical series with the frothy part was coarse, dark brown (Table 1) and comprised a mean length of 2.58 cm (Fig. 1). On the other hand, the egg mass index exhibited

the seventh rank among other co-occurring species with a value of 1.957 (Table 1). The apical lid of the pod was completely absent in all examined egg-pods. A typical egg of this species was cylindrical and slightly curved at the distal part. The color of an egg was un-mellow yellow with an average length of 4.68 mm and average width of 0.9 mm. Unique chorionic sculpture of this species was detected in which peculiar hexagons with corner and center spots were observed (Table 2).

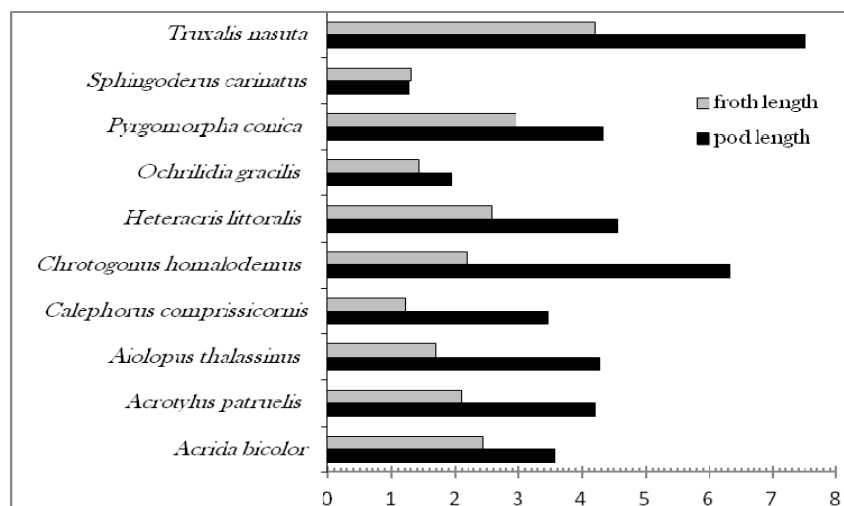


Fig. 1. Egg-pod length and froth length (in centimeters) of co-occurring grasshopper species inhabiting the study site at Manshiya district, Giza, Egypt.

***Ochrilidia gracilis* (Krauss, 1902)**

Egg-pods of this species (Acrididae: Gomphocerinae) were always cylindrical and straight with egg mass arranged in 3-4 inclined series and the apical egg-pod lid was frequently observed in some specimens while not recorded in others (Table 1). The mean length of the examined pods was 1.94 cm. The frothy part ranged in color from white to silver and exhibited a mean length of 1.42 cm. The recorded egg mass index was 1.231 which displayed the least value among other co-occurring species (Table 1). The eggs of this species were cylindrical and straight with goldenrod yellow color. The mean recorded dimensions of the eggs were 4.34 mm in length and 0.88 mm in width and the chorionic sculpture of the eggs was in the form of dots in rows.

***Pyrgomorpha conica* (Olivier, 1791)**

This species (Pyrgomorphidae: Pyrgomorphinae) showed that the examined egg-pods were cylindrical and always straight with 4-6 inclined series with the apical lid was completely absent (Table 1). The egg-pods exhibited a mean length of 4.32 cm while the frothy part was white and comprised a mean length of 2.96 cm. With respect to the egg mass index; a value of 1.273 was recorded which placed this species in the ninth rank concerning egg mass index (Table 1). The eggs were straight and occasionally slightly bent toward the anterior

pole with jonquil yellow color. The mean length and width of the eggs were 4.68 and 0.86 mm, respectively. The examined eggs were characterized by fine hexagons in the chorionic sculpture.

***Sphingoderus carinatus* (Saussure, 1888)**

The egg-pods of this species (Acrididae: Oedipodinae) were collected near *Alhagi maurorum* (Medik, 1787) where no other grasshopper species could be observed in the territory of *Alhagi* plantations. The least number of egg-pods (17 egg-pods) were collected for this species and the egg-pods were cylindrical and always straight with two obvious inclined series (Table 1). The mean length of pods of this species exhibited the least value among other collected species at the study site and it was 1.28 cm (Fig. 1). In all examined egg-pods of this species, the apical lid was always missing. The mean length of the froth was about 1.3 cm with the color ranged from silver to brown. The mean egg mass index ranked in eighth position compared to other values and the recorded index for this species was 1.615 (Table 1). The eggs of this species were cylindrical, straight and with canary yellow color. The chorionic sculpture of a typical egg was lacking with the mean dimensions of an egg were 4.72 and 1.28 mm in length and width, respectively.

***Truxalis nasuta* (Linnaeus, 1758)**

The egg-pods of this species (Acrididae: Acridinae) were cylindrical and frequently straight with air space present in many examined pods (17 egg-pods out of 26 examined ones). Egg mass arranged in two vertical series. The highest mean length for egg-pods (7.52 cm) was exhibited by this species (Fig. 1). The frothy part was white or buff in color and with mean length of 4.2 cm and the apical lid was absent. The egg mass index positioned this species in the second rank with a value of 2.355. A typical egg was cylindrical and straight tapering towards the anterior pole and beige brown in color. The mean dimensions of eggs were 5.58 mm in length and 1.02 mm in width and the dots of the chorionic sculpture were observed to be in rows.

The average number of eggs per pod varied among different species examined. Indeed, *Aiolopus thalassinus* showed the maximum average number of eggs per pod among other acridomorphine species. This was followed by *Pyrgomorpha conica*. On the other hand, *Sphingoderus carinatus* exhibited the lowest average number of eggs per pod (9 eggs only). Waloff (1950) reported that small numbers of eggs in the egg-pods occurred in some species such as *Stenobothrus lineatus* (Panzer, 1796) (6 eggs) and *Omocestus viridulus* (Linnaeus, 1758) (10 eggs). Husain and Roonwal (1933) found that the number of eggs per pod varies from 44-65 in *Schistocerca gregaria* (Forskål, 1775). Roonwal (1936) counted 35-43 eggs per pod in *Locusta migratoria* (Linnaeus, 1758), while *Acrida pellucida* (= *A. bicolor*) it was about 45-50 (Hafez & Ibrahim, 1958). Moreover, Hafez and Ibrahim (1962, 1964) found about 55-60 and 45-50 eggs per pod in *Aiolopus thalassinus* and *Sphingoderus carinatus*, respectively.

The low number of eggs could be attributed to the relatively low reproductive potential which may reflect the fact that the population of *Sphingoderus carinatus* was relatively low in Manshiya district as indicated by the relatively low number of collected egg pods (17 egg-pods).

Concerning egg arrangement, Chapman & Robertson (1958) and Chapman (1961) reported two types of egg arrangements in the egg-pod (*i*) the eggs radially arranged so that their

micropyle ends are visible all-around the pod (ii) the eggs bilaterally symmetrical arranged so that their micropyle ends are visible on only one side of the pod. In the present investigation, the two types of egg arrangements were observed. Uvarov (1977), however, reported some variation of these arrangements. Furthermore the arrangement of the eggs is often lost when the fragile pod is dug out. In addition, Uvarov (1966) reported that the size of newly laid egg mostly depends on the size of species; its length in small species is greater in relation to the female body length than in large.

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REFERENCES

- Abu ElEla, S.A., ElSayed, W. & Nakamura, K. 2010. Mandibular structure, gut contents analysis and feeding group of orthopteran species co-occurring in different habitats of Satoyama area, Japan. *Journal of Threatened Taxa*, 2(5): 849–857.
- Abu ElEla, S.A., ElSayed, W. & Nakamura, K. 2012. Incidence of orthopteran species (Insecta: Orthoptera) among different sampling sites within Satoyama area, Japan. *Journal of Threatened Taxa*, 4(3): 2476–2480.
- Chapman, R.F. 1961. The egg pods of some tropical African grasshoppers (Orthoptera: Acrididae). Egg pods from grasshoppers collected in Southern Ghana. *Journal Entomological Society of South Africa*, 24(2): 259–284.
- Chapman, R.F. & Robertson, A.D. 1958. The egg pods of some tropical African grasshoppers. *Journal Entomological Society of South Africa*, 21(1): 85–112.
- ElShazly, M.M. & ElSayed, W. 2006. The structure and host plant selection of an acridid community on the edge between a desert- and an agro-ecosystem in Egypt. *Environmental Informatics Archives*, 4: 1–25.
- Hafez, M. & Ibrahim, M.M. 1958. Ecological and biological studies on *Acrida pellucida* Klug, in Egypt. *Bulletin of the Entomological Society of Egypt*, 44: 451–476.
- Hafez, M. & Ibrahim, M.M. 1962. On the ecology and biology of the grasshopper *Aiolopus thalassinus* F. in Egypt (Orthoptera: Acrididae). *Bulletin of the Entomological Society of Egypt*, 46: 189–214.
- Hafez, M. & Ibrahim, M.M. 1964. On the biology of the immature forms of the desert grasshopper *Sphingonotus carinatus* Sauss in Egypt. *Bulletin of the Entomological Society of Egypt*, 48: 189–214.
- Hunter-Jones, P. 1961. Rearing and breeding locusts in the laboratory. *Anti-Locust Bulletin*, 1–12.
- Husain, M. A. & Roonwal, M.L. 1933. Studies on *Schistocerca gregaria* Forsk. I. The micropyle in *Schistocerca gregaria* Forsk. And some other Acrididae. *Indian Journal of Agricultural Science*, 3(4): 639–645.
- Khalifa, A. 1956. The egg-pods of some Egyptian grasshoppers and the preference of females for soils of different moisture contents (Orthoptera: Acrididae). *Bulletin of the Entomological Society of Egypt*, 40: 175–186.
- Kuehni, R.G. 2002. The early development of the Munsell system. *Color Research and Application*, 27(1): 20–27.

- Riffat, S. & Wagan, M.S. 2009. Comparative Study on the Morphology of Egg Pods, Egg Development and Hatching of Three *Hieroglyphus* species (Acrididae: Orthoptera). *Pakistan Journal of Zoology*, 41(2): 143–148.
- Roonwal, M. L. 1936. The growth-changes and structure of the egg of the African Migratory Locust, *Locusta migratoria migratorioides* R. and F. (Orthoptera, Acrididae). *Bulletin of Entomological Research*, 27(1): 1–14.
- Shah, P.A., Godonou, I., Gbongbou, C., Hossou, A. & Lomer, C. J. 1998. Survival and mortality of grasshopper egg pods in semi-arid cereal cropping areas of northern Benin. *Bulletin of Entomological Research*, 88: 451–459.
- Shahpa, W.M. El-Sayed. 2004. *Grasshoppers (Orthoptera: Acrididae) communities in Abu-Raûwash district (Giza, Egypt)*. Master of Science Thesis, Cairo University, 169 pp.
- Uvarov, B.P. 1966. *Grasshoppers and locusts. A handbook of general acridology. Vol. 1, anatomy, physiology, development, phase polymorphism, introduction to taxonomy*. University Press, Cambridge, 481 pp.
- Uvarov, B.P. 1977. *Grasshoppers and locusts. A handbook of general Acridology. Vol. 2, ecology, biogeography, and population dynamics*. Centre for Overseas Pest Research, London, 613 pp.
- Waloff, N. 1950. The egg-pods of British short-horned grasshoppers (Acrididae). *Proceedings of the Royal Entomological Society of London (A)*, 25: 115–126.
- Zafari, T. M. and Qazi, M. H. 1989. Density and parasitization of grasshopper egg-pods in Pakistan. *Insect Science and its Application*, 10(1): 63–68.

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